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Project Accomplishment Summary
For
Project Number 92-MULT-026-B2-04

APPLICATION OF HIGH PERFORMANCE COMPUTING FOR AUTOMOTIVE DESIGN AND MANUFACTURING

Thomas Zacharia
Lockheed Martin Energy Research

Argonne National Laboratory
Chrysler Corporation
Ford Motor Company
General Motors Corporation
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Sandia National Laboratory

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PROJECT ACCOMPLISHMENT SUMMARY

Project Title:	Application of High Performance Computing for Automotive Design and Manufacturing
Project Number:	92-MULT-026-B2-04
CRADA Number:	92MULT-026B2 (Y1293-0188)
Partners:	Argonne National Laboratory (ANL) Chrysler Corporation Ford Motor Company General Motors Corporation (GM) Lawrence Livermore National Laboratory (LLNL) Los Alamos National Laboratory (LANL) Sandia National Laboratory (SNL)

BACKGROUND

A Cooperative Research and Development Agreement (CRADA) was established between DOE national laboratories and US automotive companies to improve the application of high-performance computing to automotive design and manufacturing. The objective of this research project was to develop simulation models and computational solutions that addressed a list of technical priorities for these applications. In consideration of the complexity and scope of the CRADA, the work was divided among the national laboratories, the university, and the industrial partners so that each participant exploited their respective areas of expertise. The scope of work was divided into four separate projects with numerous subtasks. The four projects were: (1) Computational Fluid Dynamics (CFD), (2) Composite Material Modeling (CMM), (3) Grid Generation, and (4) Visualization.

Theoretical and computational models were developed for critical areas of automotive design. The models were implemented on high-performance computers to enable rapid simulation and design. The developed software has been incorporated into the research and commercial software and made available to automotive companies for design and research applications. New areas of research have been identified that need to be addressed to further advance the application of computational simulation in the automotive industry.

DESCRIPTION

This project developed new computer simulation tools which can be used in DOE internal combustion engine and weapons simulation programs currently being developed. Entirely new massively parallel computer modeling codes for chemically reactive and incompressible fluid mechanics with interactive physics sub-models were developed. Chemically reactive and aerodynamic flows are central parts in many DOE systems. Advanced computer modeling codes with new chemistry and physics capabilities can be used on massively parallel computers to handle more complex problems associated with chemically reactive propulsion systems, energy efficiency, enhanced performance and durability, multi-fuel capability and reduced pollutant emissions. The work for this project is also relevant to the design, development and application of advanced userfriendly computer codes for new high-performance computing platforms for manufacturing and which will also impact and interact with the U.S.'s advanced communications program.

Finite element method (FEM) formulations were developed that are directly usable in simulating rapid deformation resulting from collision, impact, projectiles, etc. This simulation capability is applicable to both DOE (e.g., surety and penetration) and DoD (e.g., armor) applications. The models of plate and shell composite structures were developed for simulation of glass continuous strand mat and braided composite in thermoset polymer matrix. The developed numerical tools based upon the fundamental mechanisms responsible for damage evolution in continuous-fiber organic-matrix composites. This class of materials is especially relevant because of their high strength to mass ratio, anisotropic behavior, and general application in most transportation and weapon delivery systems. The high-performance computational tools developed are generally applicable to a broad spectrum of materials with similar fiber structures.

BENEFITS TO DOE

The computer models developed as part of this CRADA are extremely valuable to the Office of Defense Programs in modeling/simulation of the manufacturing/assembly stress analysis of weapons components. Because the models are fairly generic, they are applicable to a wide variety of materials and processes and can be readily used in the design and manufacture of weapons components.

ECONOMIC IMPACT

The use of these computational models will greatly enhance the auto industry's ability to manufacture lightweight materials that are energy efficient. By being able to simulate complex design problems for glass fiber reinforced composites, industry will be able to model rather than use the design, build, and test routines that are costly and time consuming. Thus the industry will be able to reduce their time to market strategies.

PROJECT STATUS

The technical work has been completed.

DOE FACILITY POINT(S) OF CONTACT FOR PROJECT INFORMATON:

T. Zacharia, Director, Computer Science and Mathematics Division; PHONE: (423) 574-4897; FAX: (423) 574-4839; Building 6025, Mail Stop 6359

S. Simunovic, Research Staff; PHONE: (423) 241-3863; FAX: (423) 574-4839; Building 4500S, Mail Stop 6140

PROJECT EXAMPLES

Since this is a modeling project, the examples would be the various codes developed under the CRADA and the results of model predictions.

TECHNOLOGY COMERCIALIZATION

Thus far no inventions have been reported. However, the computer codes developed as part of the CRADA may have potential commercial applications in automotive design.

COMPANY SIZE AND POINT OF CONTACT:

Argonne National Laboratory, D. Weber
Chrysler Corporation, R. Sun
Ford, W. Hamann
General Motors, M. Botkin
Los Alamos National Laboratory, D. Butler
Lawrence Livermore National Laboratory, F. Tokarz
Oak Ridge National Laboratory, T. Zacharia
Sandia National Laboratory, B. Thomas

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